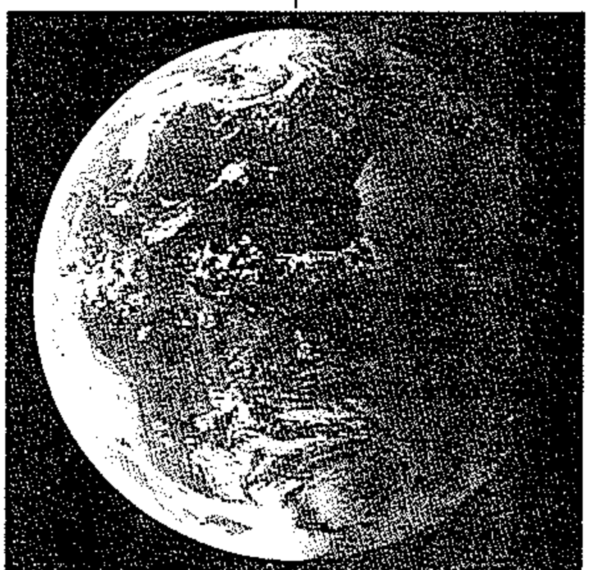
Blueprint for Change: Report from the National Conference on the

Revolution

in Earth and Space Science Education



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National Conference on the Revolution in Earth and Space Science Education

Earth and space science education is undergoing a remarkable transformation. Long perceived as a "minor" science (in contrast with physics, chemistry and biology), Earth and space science is emerging in both public perception and active science research as a profoundly important field. Our lives and future depend on the depth of our understanding of our home planet. The concept of Earth as a rich and complex system of interconnected components and processes has become a dominant paradigm in science. Furthermore, the Space Age has provided a revolutionary new perspective on Earth, enabling us to see, explore and investigate our world in ways never before possible.

The National Science Education Standards underscore this transformation through a strong emphasis on "Earth and Space Science" as a core domain of science education at all grade levels. The Standards recommend that students experience Earth and space science as a process of inquiry, exploration and discovery. This is an ideal domain for inquiry, as the "lab" is all around us, inviting exploration.

Students should also tap into the power of telecommunications and visualization technologies to see the world from the unique perspective of space and use a wide range of data – just as scientists do. NASA, USGS, NOAA and other agencies have opened their treasure trove of satellite imagery, animations, interactive maps and other visualizations for ready access by schools and the general public. The Internet helps students see how Earth's forces affect their daily lives and provides direct access to news of Earth and space science and links for further exploration. These experiences help students understand Earth as a dynamic system – rather than simply a collection of topics to read about.

The potential impact on our schools and students is not just in Earth and space science, but in the broader applicability of the skills developed by students to related domains of science, math, geography and other fields. These thinking skills include inquiry, visual literacy, understanding systems and models, and the ability to apply knowledge and problem solving to a range of substantive, real-

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world issues. In short, this revolution in Earth and space science education has benefits for all students and for our relationship with our home planet Earth.

Recognizing the importance of these changes, the National Science Foundation funded the National Conference on the Revolution in Earth and Space Science Education. The conference took place June 21-24, 2001, in Snowmass, Colorado, with the goal of developing a vision and "blueprint" for K-12 Earth and space science education reform for the next decade. The conference assembled a broad spectrum of stakeholders including K-12 teachers and administrators, Earth and space scientists, university faculty, representatives of educational and scientific organizations, key people from government agencies, and people from allied domains such as biology, chemistry and physics.

The conference featured presentations on educational projects with cutting-edge curriculum, technology and professional development. It also focused on the challenges of large-scale reform in Earth and space science education. It looked at data on the remarkably low numbers of students currently participating in Earth and space science (only 7% of the nation's high school students take Earth and space science – as opposed to 88% that take biology). Working groups looked at ways to change the content and methods of Earth and space science education, and ways to greatly expand the number of students learning Earth and space science at elementary, middle- and high-school levels.

Summary of Recommendations:

Establish state-based alliances to promote Earth and space science education reform. Alliance partners should include educators, scientists, policy makers, businesses, museums, technology centers and others concerned about improving the caliber and scope of Earth and space science education. State alliances should develop and implement concrete plans to achieve the reforms outlined in this report. These alliances should be coordinated nationally.

Develop and conduct an "Annual Snapshot" to gauge progress toward meeting the goals outlined in this report. To measure improvements in Earth and space science education, we need to collect annual data on the current status of Earth and space science education nationally and in each state, including student performance, teacher professional development and curriculum reform, and monitor these changes over time.

Student learning experiences should have a stronger emphasis on inquiry-based learning, use of visualization technologies and understanding Earth as a system. These learning goals and teaching methods build on the National Science Education Standards and the Benchmarks for Science Literacy. They also reflect the nature and current practice of Earth and space science as well as the wealth of Earth visualizations and resources available through the Internet.

At the high-school level, Earth and space science should be approved as a lab science, with depth and rigor akin to biology, chemistry and physics. Earth and space science has changed dramatically since the time when it was often regarded as a lesser science in the panoply of high-school courses. Now Earth and space science is widely considered an essential element of a science-literate society. As a lab science, Earth and space science offers a rich array of challenging field work, lab experiments and advanced computer-based visualizations.

Develop a national database of high-quality, grade-level appropriate Earth and space science assessments. A national body of scientists and educators in Earth and space science education should create a databank of assessment items organized so teachers and others can construct high-quality measures of student achievement. This database should include not only good multiple-choice and constructed response items but exemplary, performance-based assessments and scoring rubrics for elementary, middle and high school. These assessments should measure student learning of the core concepts and skills identified for Earth and space science in the National Science Education Standards and Benchmarks for Science Literacy.

Create national and state professional development academies in Earth and space science. These academies should offer both summer institutes and school-year offerings, including online learning. They should model best practices in teaching, learning and assessment. Teachers should have an array of high-quality professional development opportunities, helping them

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experience Earth and space science as an engaging domain for inquiry, exploration and discovery.

In high needs schools, enhance access to high-quality Earth and space science education for students and professional development for teachers. All students should have the opportunity to do inquiry-based investigations of Earth and space whether they live in urban, rural or suburban areas. New curricula should include cultural and place-based perspectives, such as exploring Earth and space science in urban environments. Teacher training opportunities should include working with diverse populations.

Create new opportunities for students and parents to learn about Earth and space science in informal settings. Education should continue outside the classroom with strong support and involvement from parents and in collaboration with museums, science centers, planetariums and other centers of informal science learning.

Develop a strong research program in Earth and space science education. Research on teaching and learning in Earth and space science education provides the basis for more effective curricula and teaching strategies, the appropriate use of new technologies in classroom and field settings, the professional development of teachers, and high-quality assessments.

The full report will be widely distributed, with the expectation that its recommendations will help shape the agenda, strategies and actions for Earth and space science education reform over the coming decade.

These revolutionary changes represent a timely and essential transfer of new Earth and space science knowledge, paradigms and tools from the science and education research community to the nation's teachers and students. This revolution in Earth and space science education will promote new, more effective approaches to teaching and learning. At a deeper level, this the revolution is essential to our future. A citizenry literate in the Earth and planetary sciences is essential for making informed political and economic decisions on local, regional and global levels.

For more information and a copy of the full report, visit the Web site:
www.EarthScienceEdRevolution.org.